REMOTE SENSING FOR EFFICIENT DESCRIBE RESIDENTIAL LAND USE DENSITY STRUCTURES "CASE STUDY OF BARCELONA METROPOLITAN AREA"

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Conclusion: Improve classification categories one of the image processing targets based on different kind of analyses to obtain the missing data or to dived the existing one for more class's levels. The first level of Residential urban fabric category obtained from Spot satellite images data sources as a homogeneous data (undivided data). Talking about residential density means the occupation of construction building areas of lands without volume, the neighbour categories such as Green, Street and industrial areas will affect on dividing the Residential density levels. We focused on the development of a methodology based on segmentation and buffer zone analysis for urban residential areas that may improve the urban investigation. We treat various fundamental steps based on:

1) Extract Residential Urban Fabric Classifications areas from the final classification image of.
2) Determine the homogeneity of residential pixels for special segmentation analysis for extraction of unlabelled homogeneous objects.
3) Understand the Buffer zone and segmentation Parameters for Residential Density.

From last case areas, to determine the population density needs more information to improve such as adding the heights parameters using LiDAR information. We tried to observe the relations between land use areas to understand the compact construction areas. However, the residential density that shown focused on lands occupation without height information, the parameters and the results could have a percentage of error for example high construction density will not reflect high density of population or high volume construction density. Imagery was evaluated in three stages for its use, namely, urban change detection, urban structural classification and detail of imagery to allow for counts of buildings. Urban land use is a complex system that imposes a challenge for sciences and practice. Remote Sensing based land use modelling can provide quantified and visualized, special information on the future that is otherwise difficult to obtain, that it is hoped will draw public attention and increase environmental awareness. It is up to the elected officials, community leaders, local planners, landowners, developers, and conservationists to make wise decisions and take appropriate actions. However, we concentrate to illustrate more details of classification categories by detect the Residential urban areas that could gave more details of population behaviour[1].

Abstract: Most major metropolitan areas face the growing problems of urban sprawl, loss of natural vegetation and open space. Almost everyone has seen these changes to their local environment but without a clear understanding of their impact. Remote sensing technology offers the potential for acquisition of detailed and accurate land-use information for management and planning of urban regions.

[1]Esta ponencia se desarrolla como parte de las investigaciones realizadas el marco del Proyecto DESARROLLO DE UNA PLATAFORMA PARA EL MODELADO PROSPECTIVO DE LOS PROCESOS DE URBANIZACIÓN EN LAS ZONAS COSTERAS), financiado por el Ministerio de Ciencia e Innovación, MICINN, en la Convocatoria de ayudas de Proyectos de Investigación Fundamental no orientada, en el marco de algunos Programas Nacionales del Plan Nacional de I+D+i (2008-2011). Convocatoria 2009. (CSO2009-09057).

However, Satellite data is particularly useful for detecting major changes in urban land-use because of frequent coverage, low cost and the possibility of overlaying images from different dates exactly on top of each other. The determination of land-use data with high geometric and thematic accuracy is generally limited by the availability of adequate remote sensing data, in terms of special and temporal resolution and digital analysis image techniques.

This study introduces a methodology using information on spatial images to describe urban land-use density and changes. The analysis is based on spatial analysis of land-cover structure mapped from digitally classified satellite images of the metropolitan region of Barcelona. The results show a useful separation and characterization of various types of land-uses of this area and several important structural land-cover features were identified for this study. The analysis shows the importance of the special measurements as second order image information that can contribute to more detailed mapping of urban areas and towards a more accurate characterization of spatial urban growth pattern. However, Improve classification categories one of the image processing targets based on different kind of analyses to obtain the missing data or to divide the existing one for more class's levels. The first level of Residential urban fabric category obtained from satellite images data sources as a homogeneous data (undivided data). When we are talking about residential density that's mean the occupation of construction building areas of lands because the volume is not exist in our case of study so the neighbour categories such as Green, Street and industrial areas will affect on dividing the Residential density levels. Our data source is formed by classified Spot 5 (year 2004) satellite image (False Colour image with 10m resolution) which cover the metropolitan area of Barcelona. This paper focused on the development of a methodology based on segmentation and buffer zone analysis for urban residential areas that may improve the urban investigation.

Key words: Remote sensing, Land use, Segmentation, Density

1. Introduction

Defining urban morphology in terms of the shape and density of urban land use has hitherto depended upon the informed yet subjective recognition of patterns consistent with spatial theory. In this paper we exploit the potential of urban image analysis from remotely sensed data to detect, then measure, various elements of urban form and its land use, thus providing a basis for consistent definition and thence comparison. A lot of public resources have been directed towards seeking to develop a standardised classification system and to provide as much compatibility as possible to ensure the widespread use of such categorised data obtained from remote sensor sources. The definition of "Residential densities", for example, includes those uses similarly classified. We examined the utility of Spot5 imagery for mapping residential land use and it was possible to discriminate different densities of residential development, and to separate these from commercial/industrial and agricultural areas. Difficulties arose in the discrimination of low-density residential areas due to the range of land cover types within this specific land use, and their associated spatial variability. The greater classification errors associated with these low-density developed areas were not unexpected. We found that these errors could be mitigated somewhat with techniques that consider the mode of training data selection and by incorporation of methods that account for the presence and amount of impervious surfaces. Residential density ranges from high density, represented by the multiple-unit structure of urban cores, to low density, where houses are on lots of more than an acre, on the periphery of urban expansion. This paper focuses on a methodology developed through remote sensing technology, based on the pixels and segmentation analysis of artificial residential areas. It is suggested that this methodology may improve the urban land use structures definitions, in a way that could be applied in different cities and countries.

2. The Concept

The Buffer zone wide and the percentage of construction, non-construction and the residential areas inside similar segmentation region will be the general tools to understand the Residential Urban fabric density. ENVI software will use to apply the several processes over the principal classification data; Diagram 1 illustrates our method steps: Based on the above and by the following main steps we will propose an automatic process to follow the Residential density levels. Our process will apply over small part of Barcelona city presents different classification categories of the final result as it shown in Figure 1.

Diagram 1

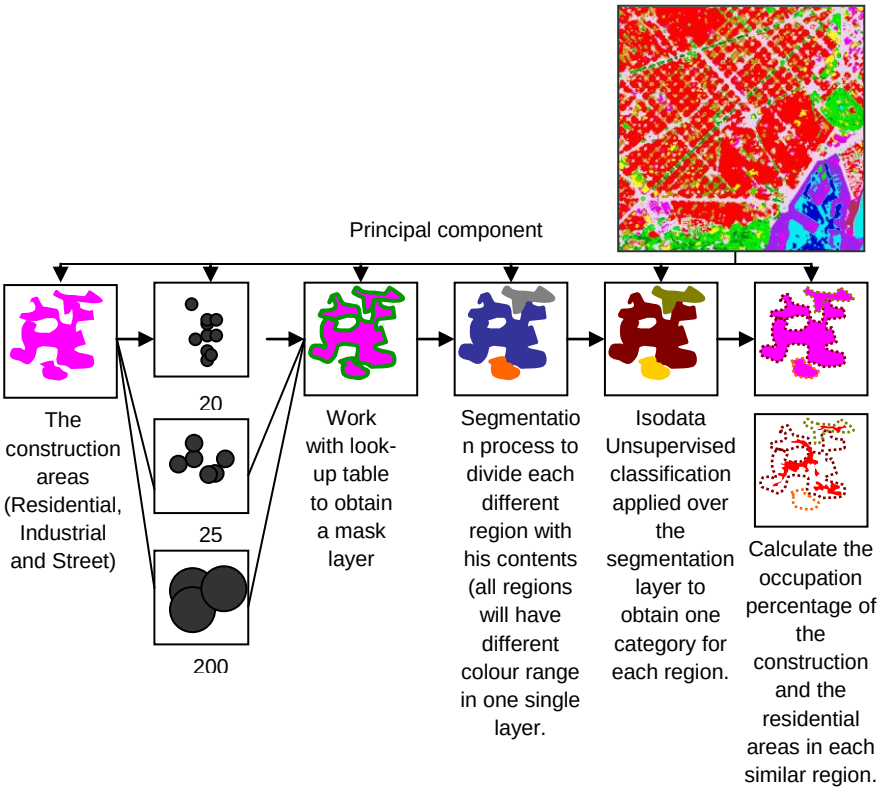
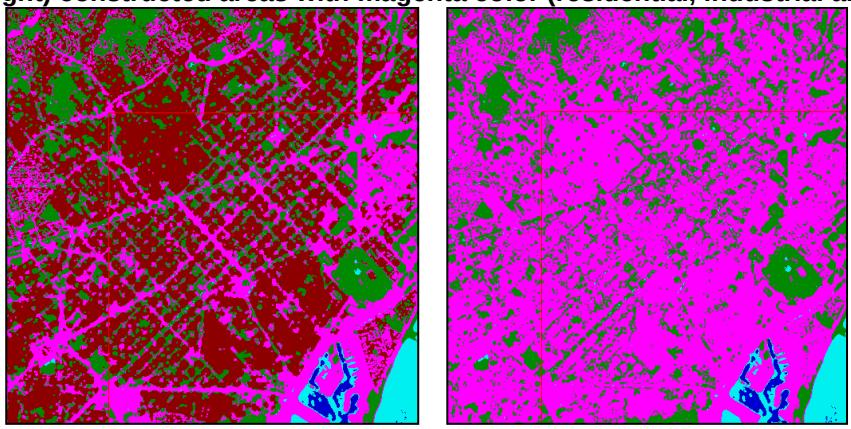


Figure 1. **(Left) Classification categories of Barcelona (the residential category is shown in red colour). (Right) constructed areas with magenta color (residential, industrial and Streets).**

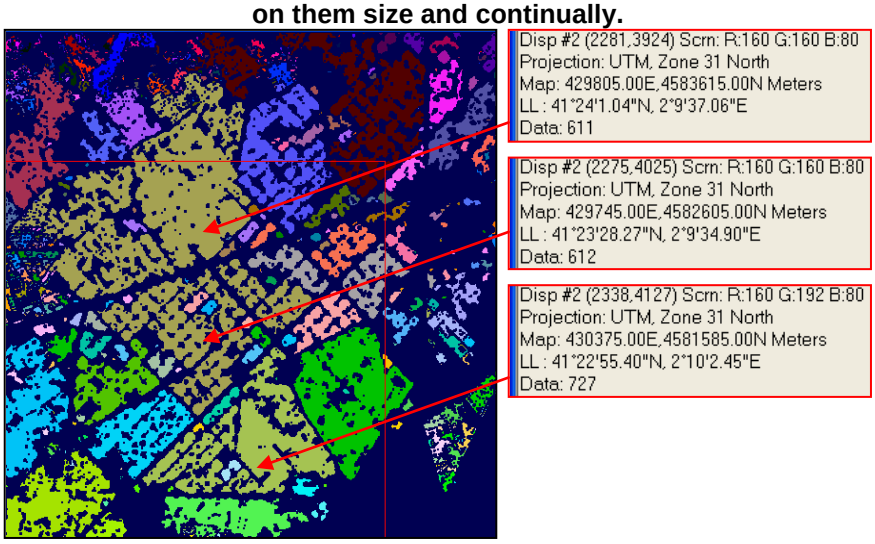


3. Methodology

3.1. Work with Segmentation

Typically the term segmentation describes the process, both human and automatic, that separates zones or regions in an image showing some characteristic with respect to a certain evaluation function. Theses characteristics could be, for example similar brightness or colour, roughness, texture. Special homogeneity of pixels plays the most important role in special segmentation, and this is widely used in remote sensing. In contrast to pixel based approach, objects or segments are formed because of their spatial correlation, not only because of their thematic similarity. Segmentation technique can be classified in to unsupervised, supervised, and split and merge segmentation methods. Unsupervised segmentation is an extraction of unlabelled homogeneous objects. Usually, number of regions to be classified is needed. Supervised segmentation uses explicit knowledge about the study area to train the segmentation algorithm on reference texture classes. In this kind of approach, segmentation and classification are combined and objects will be labelled. In our case we have the buffer zone and the construction areas in various region sizes but in the same layer, segmentation process will present the different regions sizes that could help us later to take-off the data that we need for each area and that will help to calculate the percentage of construction and residential density in each region as it shown Figure 2.

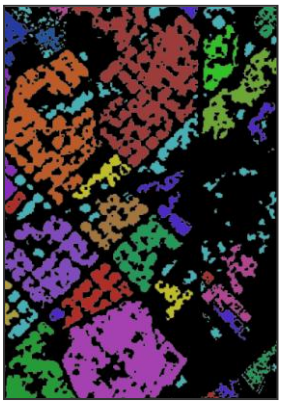
Figure 2. **The segmentation result of Residential areas will differentiate between regions depend on them size and continually.**



3.2. IsoData Unsupervised Classification

There is no specific classification categories needs in this process just in case the last process aren't able to separate various regions sizes in different layers so the solution could found in the Unsupervised classification process then will be able to calculate needs data in each layer) as it shown in Figure 3 . GIS tools such as ArcGIS could be faster and easier to separate the different regions, in he other hand the coming process could apply in the GIS tools and will give similar results but as a vector data.

Figure 3. **There are many automatic processes to analysis raster segmentation to obtain the total area for each region. Unsupervised classification with Slice density used in ENVI to obtain the result.**



	Class_Name	Class_Id	Parts	Length	Area
539	High_R [Red3] 75 points	5	1	40.000000	100.00000
540	High_R [Red3] 75 points	5	1	60.000000	200.00000
541	High_R [Red3] 75 points	5	1	120.00000	500.00000
542	High_R [Red3] 75 points	5	1	220.00000	1500.0000
543	High_R [Red3] 75 points	5	1	40.000000	100.00000
544	High_R [Red3] 75 points	5	3	6260.0000	151300.00
545	High_R [Red3] 75 points	5	1	140.00000	800.00000
546	High_R [Red3] 75 points	5	1	680.00000	8900.0000
547	High_R [Red3] 75 points	5	1	40.000000	100.00000
548	High_R [Red3] 75 points	5	3	680.00000	7700.0000
549	High_R [Red3] 75 points	5	4	2820.0000	46600.000
550	High_R [Red3] 75 points	5	1	360.00000	2600.0000
551	High_R [Red3] 75 points	5	5	3680.0000	48500.000
552	High_R [Red3] 75 points	5	45	19380.000	891700.00
553	High_R [Red3] 75 points	5	1	40.000000	100.00000
554	High_R [Red3] 75 points	5	2	2140.0000	24500.000
555	High_R [Red3] 75 points	5	2	680.00000	12600.000
556	High_R [Red3] 75 points	5	1	180.00000	600.00000
557	High_R [Red3] 75 points	5	1	40.000000	100.00000
558	High_R [Red3] 75 points	5	1	100.00000	400.00000
559	High_R [Red3] 75 points	5	1	40.000000	100.00000

3.3. Work with Buffer Zones

The buffer zone (10m and 20m) will apply over the residential category to determine the high and medium density areas. The following images (Figures 4, 5) present buffer zone with 10m and 20m arround Residential structores cover: The buffer zone (200m) will apply over the construction categories (Residential, Industrial, streets, etc) to determine the Discontinue and Spars residential areas.

Figure 4. **(Left) 10m, 20m buffer applied over each different region areas. (Right) Red colour shows 10m buffer zone, Yellow colour presents the 20m buffer zone.**

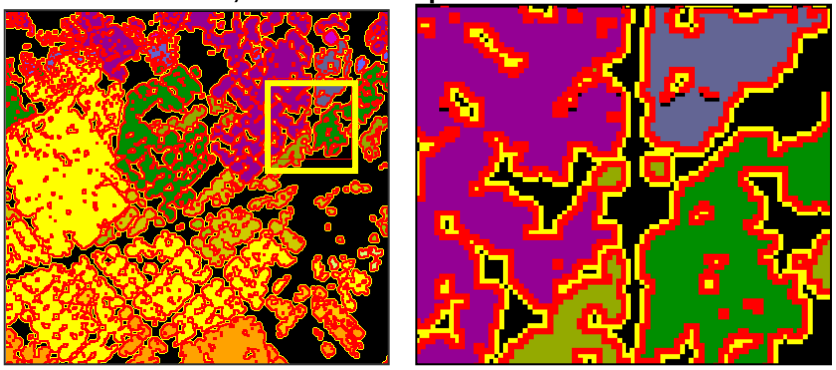
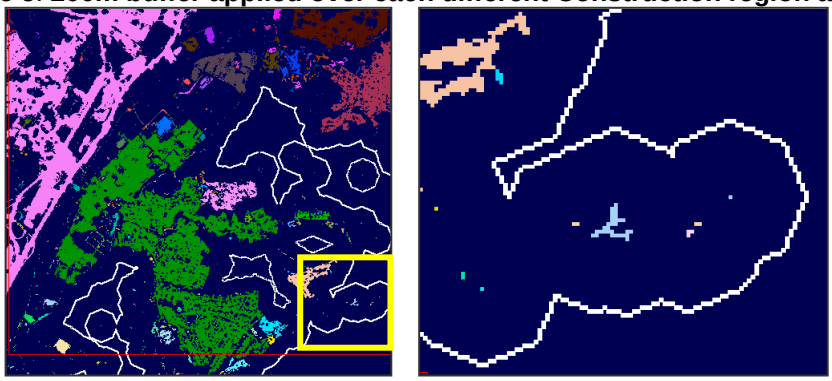


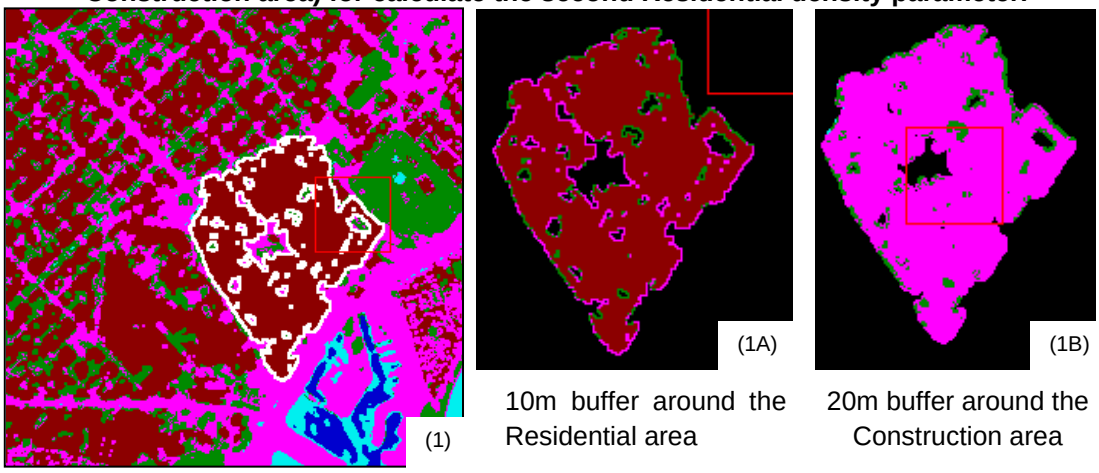
Figure 5. **200m buffer applied over each different Construction region areas.**



3.4. Data Extraction and Residential Density Parameters

Each category with his different buffer zone will use to calculate the construction categories, Figure 6 illustrate original data source (classification image) overplayed with known buffer zone in vector statue. The following Table 1 illustrates the relation between the buffer zone and occupation land percentage to determine the residential density areas from classification images:

Figure 6. **(1) From the final classification results reduced all categories in 3 categories: 1- Industrials, Streets, Ports, etc to Construction areas. 2- Residential areas. 3- Forests, Agricultures, Irrigated fields, Dry lands, etc to Non Construction areas. (1A) illustrate extraction sample data for the first parameter to calculate the residential density. (1B) present joined data (Residential + Construction area) for calculate the second Residential density parameter.**



Following above table Figure 6 had been shown *residential continues high density urban fabric*. By using last table as an indicator the following example will present clear idea for how it works over several segmentation areas. Figure 7 presents *residential continues medium density urban fabric* which residential structure areas cover *Less than 50%* of the total region surface and buildings, roads and other artificially surface areas (Artificial construction areas) cover more than *80% of the total region surface*. Figure 8 presents *residential discontinues spars urban fabric* which Buildings, Roads and other artificially surface areas (Artificial Construction Areas) cover *between 10% and 50%* of the total region surface.

Tabla 2 The relation between land occupation and surrounding contents could help to identify the occupation densities.

	Buffer Zone 10m	**Buffer Zone 20m**	**Buffer Zone 200m**

Residential Continues High Density urban fabric		Buildings, Roads and other artificially surface areas (Artificial Construction Areas) cover **more** than **80%** of the total region surface. **(Buildings + Roads + Ports + Mineral Extraction + …etc)**	
	Residential Structure areas cover **more** than **50%** of the total region surface.		
Residential Continues Medium Density urban fabric		Buildings, Roads and other artificially surface areas (Artificial Construction Areas) cover **more** than **80%** of the total region surface. **(Buildings + Roads + Ports + Mineral Extraction + …etc)**	
	Residential Structure areas cover **Less** than **50%** of the total region surface.		
Residential Discontinues urban fabric			Buildings, Roads and other artificially surface areas (Artificial Construction Areas) cover **between 50%** and **80%** of the total region surface.
Residential Discontinues Spars urban fabric			Buildings, Roads and other artificially surface areas (Artificial Construction Areas) cover **between 10%** and **50%** of the total region surface.

Figure 7. **(1) Final classification results reduced all categories in to 3 categories. (1A) illustrate extraction sample data with buffer 10m.**

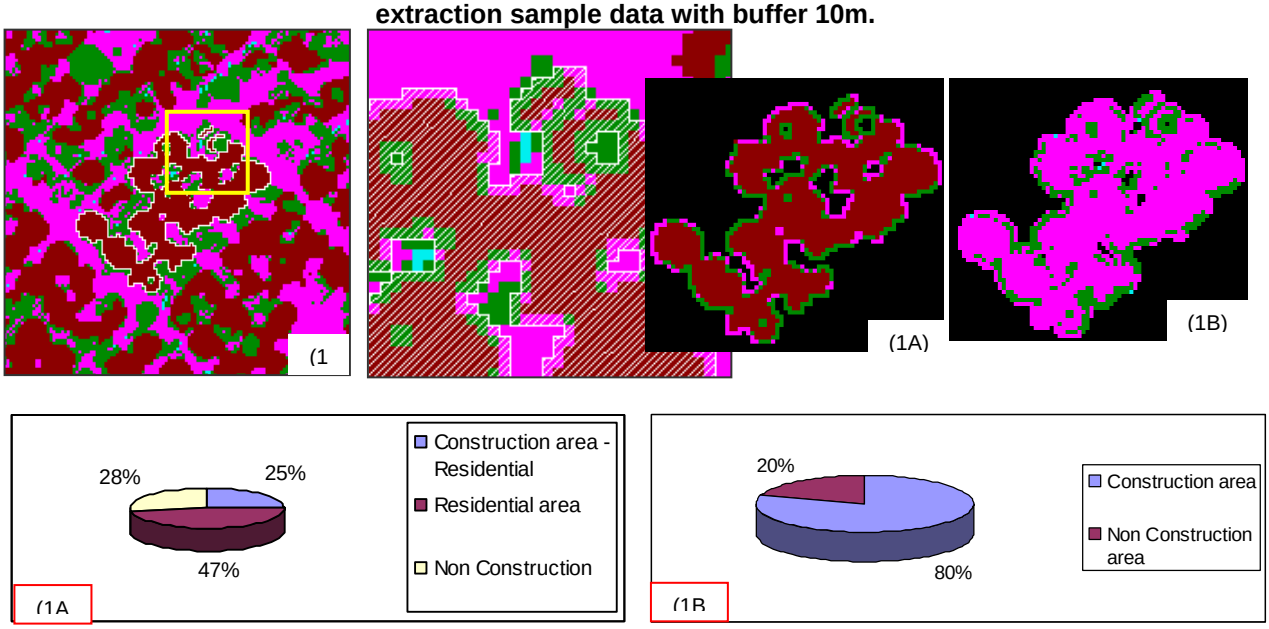
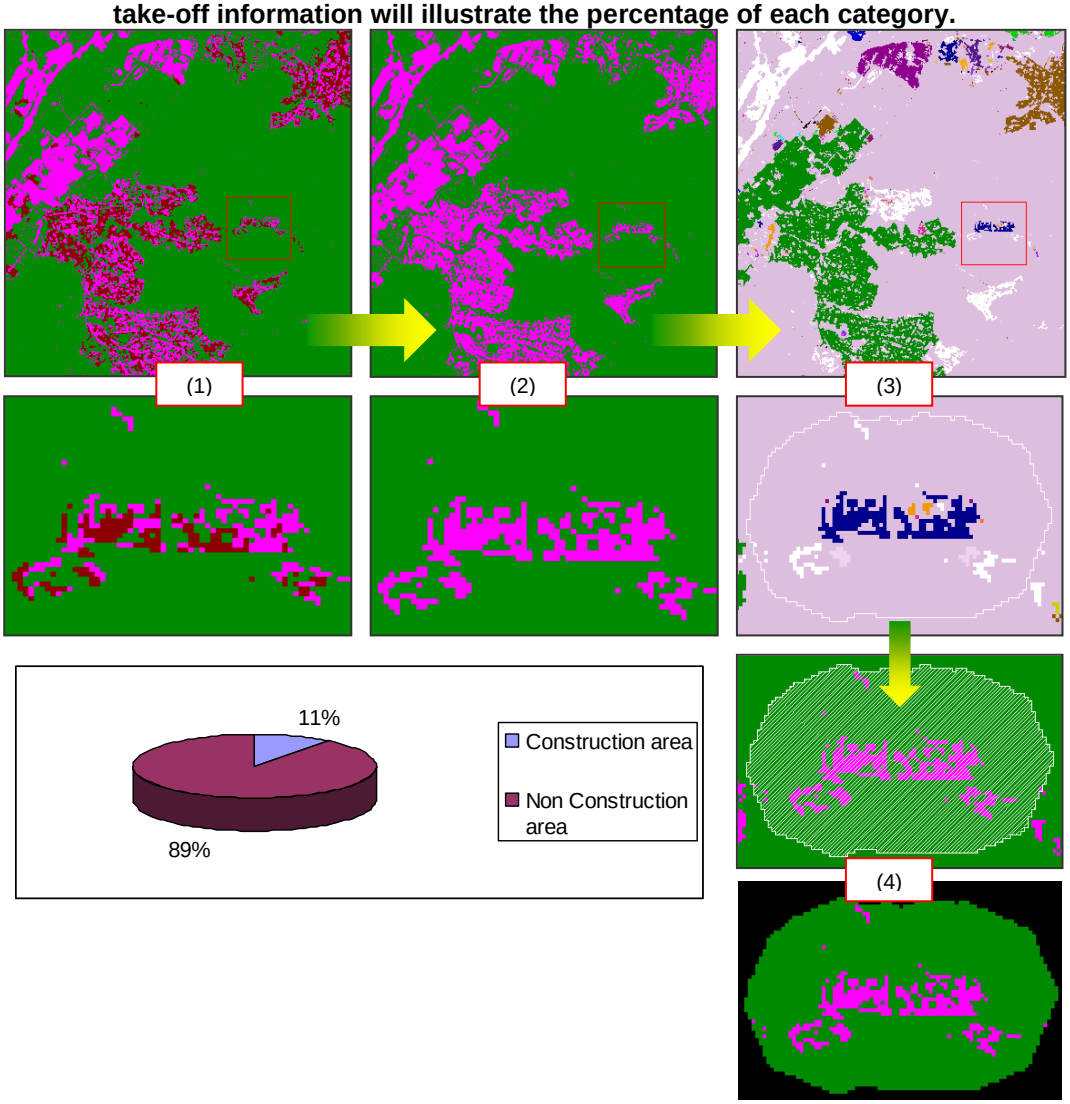


Figure 8. **(1) Snapshot case study area to explorer the effectiveness of the last parameters to determine the Discontinues and Spars Residential areas, the image show merged categories from the final classification image. (2) The density parameters to determine the Discontinues and Spars Residential areas will be over just the construction areas including the building areas too, the image show two categories (construction + Non construction areas). (3) Segmentation process and unsupervised classification applied to separate each region to calculate their contents, the image show one region with 200 buffers zone as a sample to observe the concept of work. (4) take-off information will illustrate the percentage of each category.**



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